# APPENDIX B
# LIMITED VISIBILITY OPERATIONS

*The reconnaissance platoon must be able to operate under limited visibility conditions. This appendix discusses the equipment and techniques used to operate in darkness, smoke, dust, fog, heavy rain, or heavy snow. Limited visibility can result in decreased target acquisition capability, difficulty in distinguishing friendly from enemy units, difficulty in controlling movement, and reduced target acquisition times.*

## B-1. PLANNING

In addition to normal planning, limited visibility operations require special emphasis on the following:

- Simple tactical plans while maintaining the necessary level of detail.
- Plans for the potential use of illumination and smoke.
- Surveillance with night vision and infrared devices.
- Greatest use of available daylight for reconnaissance.

In selecting a means to employ illumination or smoke, leaders must determine the type of assets that are available, to include capabilities and limitations. They plan for more than one means since enemy action, changes in weather, other missions, or logistical constraints might prevent the use of any one type.

## B-2. NIGHT-VISION DEVICES

Night-vision devices (Table B-1, page B-2) aid surveillance/target engagement when darkness, vegetation, weather, camouflage, or obscurants limit natural vision. The degree of assistance depends on the type of technology and the visibility conditions. For example, image intensification devices dominate the battlefield and provide the best results under clear air and good ambient light conditions, but they are defeated by bad weather, darkness, and battlefield obscurants. Thus, thermal imagery devices are used in conditions that defeat image intensifiers. Thermal imagery can also penetrate camouflage. Remote sensors are employed in dead space or in situations of long distances. The reconnaissance platoon should use thermal imagery devices whenever possible to provide the best surveillance and engagement capability.

| DEVICE | CAPABILITIES | CHARACTERISTICS | ADVANTAGES & DISADVANTAGES |
|---|---|---|---|
| **AN/PVS-2** Night-Vision Sight, Individual Weapon | 300-400 m | WEIGHT: 6 lb.<br>POWER: 3.6X<br>FIELD OF VIEW (FOV): 10.4 degrees | (See NOTE.) |
| **AN/TVS-2** Night-Vision Sight, Crew-Served Weapon | Starlight: 800 m<br>Moonlight: 1,000 m | WEIGHT: 16 lb.<br>POWER: 6.5X<br>FOV: 6 degrees | (See NOTE.) |
| **AN/TVS-4** Tripod or vehicle mounted sight | Starlight: 1,200m<br>Moonlight: 2,000 m | WEIGHT: 34 lb.<br>POWER: 7X<br>FOV: 9 degrees | (See NOTE.) |
| **AN/PVS-4** Night-Vision Sight, Individual Weapon | Starlight: 400 m<br>Moonlight: 600 m | WEIGHT: 3.9 lb.<br>POWER: 3.8X<br>FOV: 15 degrees | (See NOTE.) |
| **AN/TVS-5** Night-Vision Sight, Crew-Served Weapon | Starlight: 1,000 m<br>Moonlight: 1,200 m | WEIGHT: 7.5 lb.<br>POWER: 6.5X<br>FOV: 9 degrees | (See NOTE.) |
| **AN/PVS-7** Night-Vision Goggles | Starlight: 75 m<br>Moonlight: 300 m | WEIGHT: 1.9 lb.<br>POWER: 1X<br>FOV: 40 degrees | (SEE NOTE.) |
| **AN/PVS 14** Night-Vision Goggles | Starlight: 150 m<br>Moonlight: 300 m | WEIGHT: 1.5 lb.<br>FOV: 40 degrees | (See NOTE.) |
| **AN/TAS-5** Thermal Dragon Sight | 1,200 m | WEIGHT: 22 lb. | Penetrates all conditions of limited visibility and light foliage. Has short battery and coolant bottle life. |
| **COMMAND LAUNCH UNIT** (CLU) of the Javelin AT weapon system. | Over 3,000 m | Weight (CLU only) 14.1 lb<br><br>Sight magnification 4X day, 4X and 9X night | Infrared crossover.<br><br>When temperature of soil, water, concrete, and vegetation are approximately the same, CLU performance is degraded (twice in a 24-hr period). |
| **AN/UAS-12** Thermal TOW Sight | 3,000 m | WEIGHT: 18.7 lb.<br>POWER: 12X | Same as AN/TAS-5. |
| **AN/UAS-11** Thermal Night Observation Device | 3,000 m | WEIGHT: 58.4 lb. with tripod | Penetrates all conditions of limited visibility and light foliage. Has short battery and coolant bottle life. |
| **BINOCULARS** | Intensifies natural light | 7X50 or 6X30 | Require some type of visible light. |
| **AN/PAQ-4** Infrared Aiming Light | 150 m | WEIGHT: 9 lb.Used with AN/PVS-5 or AN/PVS-7 mounts on M16 | Detectable. Permits aimed fire during darkness. |
| **NOTE:** This night-vision device performs poorly in dark, obscured, or adverse weather conditions. Bright light, such as that from street lights or headlights, defeats it. Eye fatigue occurs after 3 to 5 hours. | | | |

**Table B-1. Night vision devices.**

| DEVICE | CAPABILITIES | CHARACTERISTICS | ADVANTAGES & DISADVANTAGES |
|---|---|---|---|
| **AN/PAS-7**<br>Handheld Thermal Viewer | DETECTION RANGE:<br>Vehicles: 1,000 m<br>Personnel: 400 m | WEIGHT: 10.8 lb.<br>POWER: 2.5X | Penetrates all conditions of limited visibility and light foliage. |
| **AN/PPS-5B**<br>Radar | MINIMUM RANGE:<br>50 m<br>MAXIMUM RANGE:<br>Vehicles: 10,000 m<br>Personnel: 6,000 m | WEIGHT: 112 lb. | Detectable. Degraded by heavy rain, snow, dense foliage, and high winds. Line of sight. Has 50-foot remote capability. Difficult to man-pack. |
| **AN/PPS-15A**<br>Radar: Very Short Range | MINIMUM RANGE:<br>50 m<br>MAXIMUM RANGE:<br>Vehicles: 3,000 m<br>Personnel: 1500 m | WEIGHT: 18 lb.<br>Audible and visual alarm. | Detectable. Can be operated and transported by one man. Degraded by heavy rain, snow, dense foliage, and high winds. Reduced effectiveness during wind-blown rain. Line of sight. Has 30-foot remote capability. |
| **PEWS**<br>Platoon Early Warning System | Detects target 15 m from sensor. Two types of sensors in each set distinguish personnel or vehicles. Covers a frontage of 250 m. Can be placed up to 1,500 m from platoon. | WEIGHT: 13 lb.<br>Nine ground sensors relay to monitor through wire or radio connection. | When connected by wire, is not detectable. Easy to operate. Not affected by climatic conditions. Animals can interfere with sensors. |

**Table B-1. Night vision devices (continued).**

## B-3. EQUIPMENT EMPLOYMENT

This paragraph discusses the types of equipment that can be used during limited visibility and the factors to consider when employing them.

a. **Binoculars**. Binoculars are most effective in clear air. Even during reduced visibility, however, they are better than the unaided eye.

b. **Remotely Employed Sensors**. Remotely employed sensors (REMS), such as the PEWS, are critical to effective security in limited visibility. They may be employed to monitor avenues of approach, possible assembly areas, DZs, LZs, obstacles, and dead space forward of or between OPs. REMS have a limited range; therefore, careful analysis of where to position sensors is most important. When they are positioned parallel to the avenue of approach, REMS can detect the direction, rate of march, composition, and size of a force passing the sensors.

c. **Thermal Imagery Devices**. Thermal imagery devices lose some effectiveness during heavy rain, dense fog, or smoke. Therefore, they must be integrated with other devices to provide effective detection. Thermal imagery devices are affected by temperature gradients between the target and the target background.

d. **Image Intensification Devices**. The range of image intensification devices depends on surrounding light levels. Low light levels, rain, fog, smoke, and dust may reduce the effectiveness of image intensification devices. Low light levels during periods of otherwise clear air can be overcome by illuminating with invisible light and by using image intensifiers. Infrared light provides enough light to allow the image intensifiers to be effective. However, looking directly at a visible light source causes the device to shut off. Operators of image intensification devices develop eye fatigue and lose their unaided night vision (see paragraph B-14).

e. **Ground Surveillance Radar**. Radar energy produced by GSR penetrates light camouflage, light foliage, smoke, haze, light rain and snow, and darkness. It cannot penetrate dense undergrowth, trees, or heavy foliage. Radar sets have only a line-of-sight capability. High winds can make the radar unusable, and heavy rain or snow restricts radar detection abilities. A well-trained operator, however, can lessen these effects. Radar is effective during good visibility as well as bad. Its use should be planned for all operations--not just night operations or when expecting smoke.

(1) Normally, radar is located on dominant terrain. A radar site and an OP can be collocated, but soldiers who operate the radar should not be detailed as ground observers except in emergencies. The radar is dug in and camouflaged. The reconnaissance platoon leader (or S2) selects the general location for the radar site. The ground surveillance section leader or team leader then chooses the specific site within that location.

(2) The team's senior radar operator prepares radar surveillance cards. One copy of this card is forwarded to the S2 for use in preparing or modifying his surveillance plan.

(3) Radar can be used for the following purposes:

- To search avenues of approach, possible enemy attack positions, assembly areas, or other sectors. It can be used continuously to determine location, size, and nature of enemy activity.
- To monitor point targets such as bridges, defiles, or road junctions. It can be used to determine quantity, type, direction, and rate of target movement through the point.
- To extend a patrol's observation abilities by enabling the patrol to survey distant points or areas of special interest.
- To provide warning of enemy activity near friendly positions or routes.
- To detect partly obscured targets.
- To aid in controlling movement during limited visibility by monitoring course headings or vectoring.
- To increase the effectiveness of fire support by correctly locating targets. It can also be used to survey target areas immediately after fires are lifted, to detect enemy activity, and to determine the effectiveness of fire.
- To detect enemy radar.
- To limit the enemy's ability to detect radar and mask the emitter. Terrain is used to mask the emitter, if possible. The radar is placed in a reverse-slope position with its sector off to the flank(s). Radar that is left on is easier to detect. The flicker technique (alternately turning radar off and on) can help avoid enemy detection.

## B-4. DEVICE INTEGRATION

The reconnaissance platoon leader plans the use of NVDs and surveillance devices to obtain the best coverage of his area of operations and to make best use of the abilities of the various devices (Figure B-1). A typical mix might include REMS to cover out-of-sight objectives and dead space, night-vision sights for close range, radar for long-range line of sight, and thermal imagery to penetrate smoke and for use in low-light conditions.

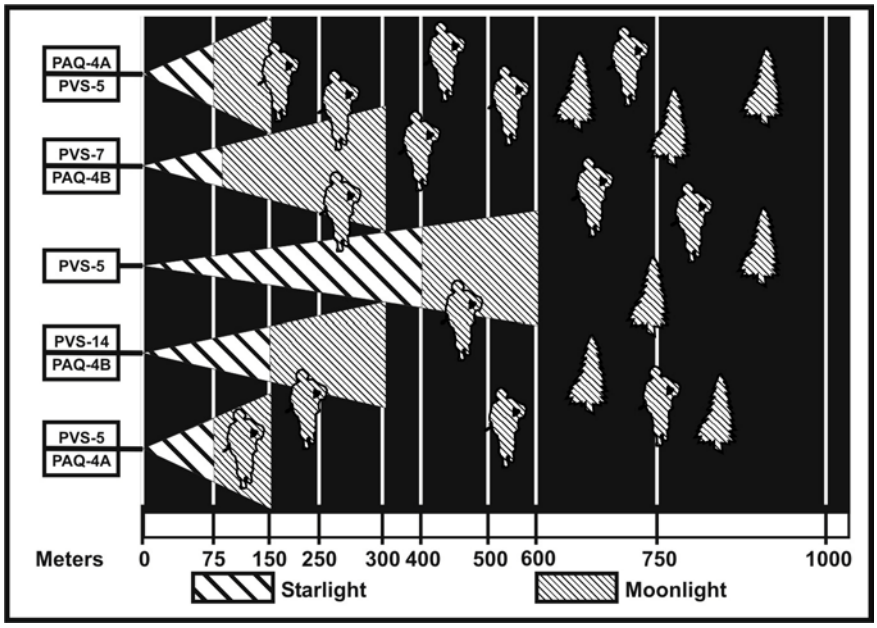


**Figure B-1. Device integration.**

## B-5. ENEMY NIGHT-VISION AND SURVEILLANCE DEVICES

Soldiers avoid detection by the enemy by moving stealthily. Defensive measures include cover and concealment, use of appropriate camouflage devices and methods, concealment of actions with smoke, and thermal and visual decoys.

## B-6. BATTLEFIELD ILLUMINATION

When night vision devices are not available, artificial light is the simplest way to operate on a battlefield during darkness. The intent is to illuminate or silhouette the enemy force without illuminating friendly elements and to prevent the illuminating force from being adversely affected by its own light source. Platoon leaders must know the characteristics of available artificial illumination systems (Table B-2, page B-6). They must also know how darkness, weather, and terrain influence these systems. The platoon leader must exercise positive control over the use of various illumination means since illumination in one area might have an unfavorable effect on elements elsewhere. He must also obtain approval from the battalion before using illumination. Artificial light is divided into two categories: visible and invisible light.

a. **Visible Light**. Visible light requires no special equipment other than the light source itself. It is used to continue operations begun during daylight, to assist troops that are untrained, or to offset an enemy advantage in NVDs. It is the simplest method of

operating during darkness. The disadvantage of using visible light is that it permits the enemy to see the friendly force.

b. **Invisible Light**. Invisible light comes from a near-infrared source, ultraviolet light, or pink light filter. It is normally impossible to see this light with the unaided eye. Although it is visible to NVDs, invisible light has greater security than visible light.

| Device/System | Approximate Diameter of Usable Range of Illumination (meters) | Approximate Period of Illumination (seconds) |
|---|---|---|
| White Star Parachute | 450 | 36 |
| Illuminating Grenade | 200 | 25 |
| Trip Flare | 300 | 55 |
| 40-mm White Star Parachute | 150 | 15 |
| 60-mm Mortar | 800 | 25 |
| 81-mm Mortar | 1,100 | 60 |
| 120-mm Mortar | 1,500 | 50 to 60 |
| 105-mm Howitzer | 1,000 | 60 |
| 155-mm Howitzer | 2,000 | 120 |
| Air Force Drop Flare | 1,500 | 180 |
| Naval Gunfire, 5 Inch | 350 to 550 | 45 to 52 |

**Table B-2. Available light sources.**

## B-7. EMPLOYMENT CONSIDERATIONS FOR ARTIFICIAL LIGHT SOURCES

Various considerations govern the use of artificial light sources.

a. **Ground Flares**. Ground flares are mainly defensive, are good for early warning, and can be detonated remotely by pull-pin or trigger-release devices. Ground flares are not suitable for continuous illumination.

**WARNING**
**Ground flares may start fires.**

b. **Illuminating Shells (Parachute-Supported Flares)**. After the parachute opens, windspeed, direction, and the amount of obscurant determine what ground area is lighted. Shells are normally set to detonate at a height of burst that allows the flare to burn out just before it reaches the ground. Drifting flares can illuminate friendly forces; therefore, the detonation point must be adjusted either by offsetting it or lowering the height of burst. If grass or brush fire is a hazard, the height of burst is not lowered. Strong winds require that the rate of fire be increased for continuous illumination. Fog, dust, smoke, and falling snow decrease the intensity of the illumination. Therefore, low-airburst shells can be used as navigational aids even though they provide little illumination.

**WARNING**

**Avoid detonating illumination over or to the rear of friendly elements. This could silhouette friendly troops.**

## B-8. SMOKE OPERATIONS

Smoke is used to blind the enemy, to break contact with the enemy, to signal, or to deceive.

a. **Obscuration Smoke**. Obscuration smoke is placed on or near enemy positions to interfere with observation and fire. It is usually delivered by indirect fire such as artillery or mortars. Use of obscuration smoke on the enemy could cause him to reduce speed, to change direction, to deploy prematurely, or to increase radio transmissions.

b. **Screening Smoke**. Screening smoke is intended to conceal friendly forces and to help break contact with the enemy.

c. **Marking and Signaling Smoke**. Marking and signaling smoke is used to mark reference points, targets, or positions. Colored or WP smoke is usually used.

d. **Deceptive Smoke**. To confuse or mislead the enemy, deceptive smoke is used in coordination with other actions by creating the illusion that a tactically major event is occurring. It is used with other deceptive measures such as electronic deception.

## B-9. SMOKE EFFECTS

Smoke can affect both the psychological and physiological aspects of soldiers' activities. Therefore, it can also affect combat operations.

a. **Psychological Effects**. Screening smoke near friendly positions to reduce enemy observation can help maintain morale when soldiers are aware of its purpose. However, soldiers operating in smoke can develop fear or anxiety due to the lack of visibility to detect the enemy, to see adjacent units, or to distinguish terrain features. This causes orientation problems. Smoke tends to isolate individuals or groups and degrades their ability to fight. Soldiers in this situation are vulnerable to deception through other sensory perceptions such as sound. Leaders at all levels can suffer these effects and, due to the need for constant and detailed command and control, can suffer mental exhaustion in a short time.

b. **Physiological Effects**. Though smoke produced by mechanical generators or munitions might not produce immediate physiological effects, extended exposure to large concentrations can produce secondary effects such as shortness of breath, inflammation of the respiratory system, dizziness, vertigo, or vomiting. Donning the protective mask limits these effects. Vertigo can be overcome by leaving the smoke area or by getting close to the ground. Chemical agents can also be delivered with smoke. The leader must analyze the risk of masking, which may be unnecessary and may cause command and control problems.

## B-10. OPERATIONAL FACTORS

Battalion may direct the reconnaissance platoon to assist in smoke operations. Unless directed by battalion, the platoon uses smoke only in situations in which they must break contact. By limiting vision, smoke degrades the ability of soldiers and combat forces to maneuver, fight, and visually communicate. Furthermore, it restricts observation of

surrounding terrain and of other combat elements on the battlefield. The natural tendency of a vehicle driver is to avoid entering smoke, to move out of or around it, or to slow movement upon entering it.

## B-11. TYPES OF SMOKE

White phosphorus and hexachloroethane (HC) are the two predominant types of smoke used today.

a. **Field Artillery**. Field artillery smoke ammunition includes both WP and HC (Table B-3).

b. **Mortars**. Mortars provide good initial smoke coverage due to their high rate of fire, but their small basic load size limits the size and duration of the screen mortars can provide. The only type of smoke round delivered by mortars is WP (Table B-4).

c. **Smoke Pots, Smoke Grenades, and M203 Dual-Purpose Weapons (Smoke Round)**. A variety of smoke-producing items are available to the battalion through standard issue. Due to their limited ranges, these smoke producers are useful only for close obscuration requirements.

| FIELD ARTILLERY DELIVERY SYSTEM | TYPE OF ROUND | TIME TO BUILD EFFECTIVE SMOKE | AVERAGE BURNING TIME | WIND DIRECTION | | |
|---|---|---|---|---|---|---|
| | | | | CROSS | QUARTER-ING | HEAD/TAIL |
| 155-mm | WP | 1/2 min | 1 to 1 1/2 min | 100 | 75 | 50 |
| | HC | 1 to 1 1/2 min | 4 min | 350 | 250 | 75 |
| 105-mm | WP | 1/2 min | 1 to 1 1/2 min | 75 | 60 | 50 |
| | HC | 1 to 1 1/2 min | 3 min | 250 | 175 | 50 |
| | | | | Average Obscuration Length (m) Per Round | | |

**Table B-3. Artillery smoke ammunition.**

| MORTAR DELIVERY SYSTEM | TYPE OF ROUND | TIME TO BUILD EFFECTIVE SMOKE | AVERAGE BURNING TIME | WIND DIRECTION | | |
|---|---|---|---|---|---|---|
| | | | | CROSS | QUARTER-ING | HEAD/TAIL |
| 120-mm* | WP | 1/2 min | 1 min | 200 | 80 | 40 |
| 81-mm | WP | 1/2 min | 1 min | 100 | 60 | 40 |
| 60-mm** | WP | 1/2 min | 45 sec | 60 | 30 | 20 |
| * The 120-mm mortar is a better smoker than the 105-mm Howitzer firing WP.<br>** The 60-mm smoke round currently in inventory is the M302E2 (maximum range: 1,448 m). | | | | Average Obscuration Length (m) Per Round | | |

**Table B-4. Mortar smoke ammunition**.

## B-12. EFFECTS OF SMOKE ON ELECTRO-OPTICAL SYSTEMS

Electro-optical systems allow soldiers to engage any target they can see with direct fire out to 3,750 meters. They also improve the soldiers' ability to see and engage targets at night. The use of smoke at night is effective in defeating electromagnetic energy-producing systems, thus making it an important element in night operations.

a. Electro-optical systems normally found on the battlefield include--
- Handheld thermal viewers.
- Wire-guided, optically tracked antitank missiles and nightsights.
- Laser range finders.
- Television-seeker missiles and bombs.
- Heat-seeking missiles.

b. All electro-optical systems work by radiating or receiving electro-optical energy. Smoke affects these systems by reflecting, absorbing, scattering, or attenuating (weakening) electromagnetic energy.

## B-13. TACTICAL CONTROL TECHNIQUES

To overcome the problems generated when soldiers cannot see the battlefield, the platoon leader and his subordinate leaders must employ other techniques to control their subordinates.

a. **Identification**. Recognition means include radio, infrared, and radar. These are used with other established audible and visual signals.

b. **Movement**. Visual contact should be maintained; soldiers should maintain closer intervals. NVDs allow soldiers to retain good dispersion while maintaining visual contact. The leaders should reduce rate of movement and establish SOPs for audible and visual signals.

c. **Navigation**. Guides should be used whenever possible.

(1) Use radar or low-light sources to mark boundaries.

(2) Use radar, infrared beams, and landmarks to maintain direction.

(3) Use preplanned artillery spotting rounds to help determine location and direction.

## B-14. DARK ADAPTATION

Dark adaptation is the process by which the human body increases the eyes' sensitivity to low levels of light. Soldiers adapt to darkness at varying degrees and rates. During the first 30 minutes in the dark, eye sensitivity increases about 10,000 times, but not much after that.

a. Dark adaptation is affected by exposure to bright light such as matches, flashlights, flares, or vehicle headlights. Full recovery from these exposures can take up to 45 minutes.

b. Using night-vision goggles impedes adaptation. However, if a soldier adapts to the dark before donning the goggles, he gains full dark adaptation within two minutes when they are removed.

c. Soldiers must also know that color perception decreases at night. They may be able to distinguish light and dark colors depending on the intensity of reflected light. Visual sharpness is also reduced. Since visual sharpness at night is one seventh of what it is during the day, soldiers can see only large, bulky objects. This means that object identification at night is based on generalized contours and outlines. Depth perception is also affected.

## B-15. NIGHT VISION

Darkness affects the senses of sight, hearing, and smell. Sharpening these senses requires training. Soldiers must know how their eyes function at night to use them best.

a. **Night-Vision Scanning**. Dark adaptation is only the first step toward making the best use of night vision. Scanning enables soldiers to overcome many of the physiological limitations of their eyes. It can also reduce visual illusions. This technique involves looking from right to left or left to right using a slow, regular scanning movement (Figure B-2). At night, soldiers must avoid looking directly at a faintly visible object when trying to confirm its presence.

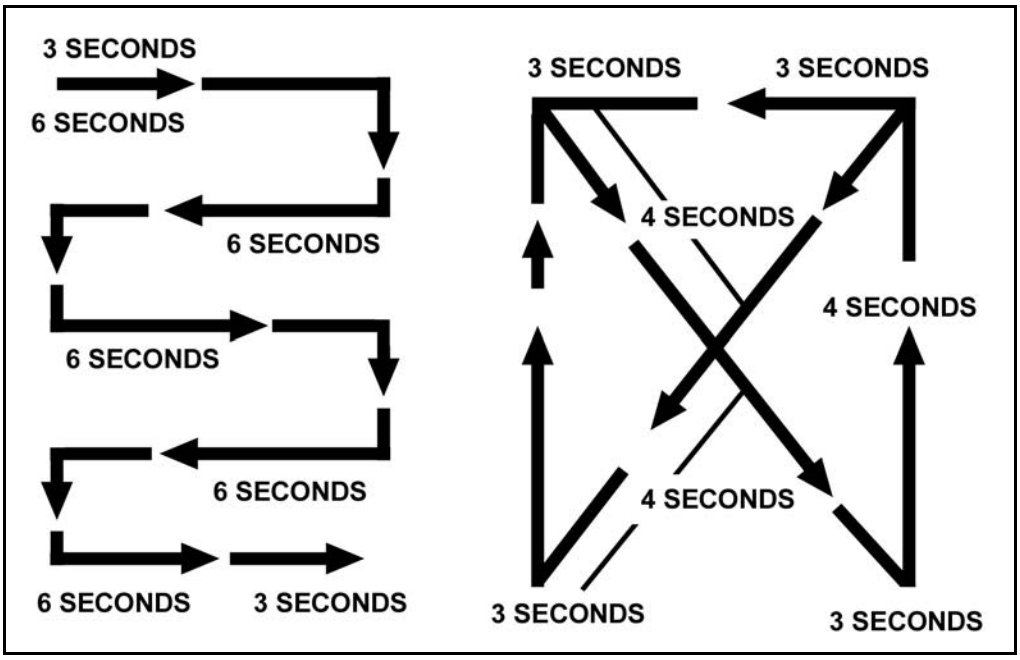


**Figure B-2. Typical scanning pattern.**

b. **Off-Center Vision**. The method of viewing an object using central vision is ineffective at night. This is due to the night blind spot that exists during low illumination. Soldiers must learn to use off-center vision. This method requires viewing an object by looking 10 degrees above, below, or to either side of it rather than directly at it (Figure B-3).

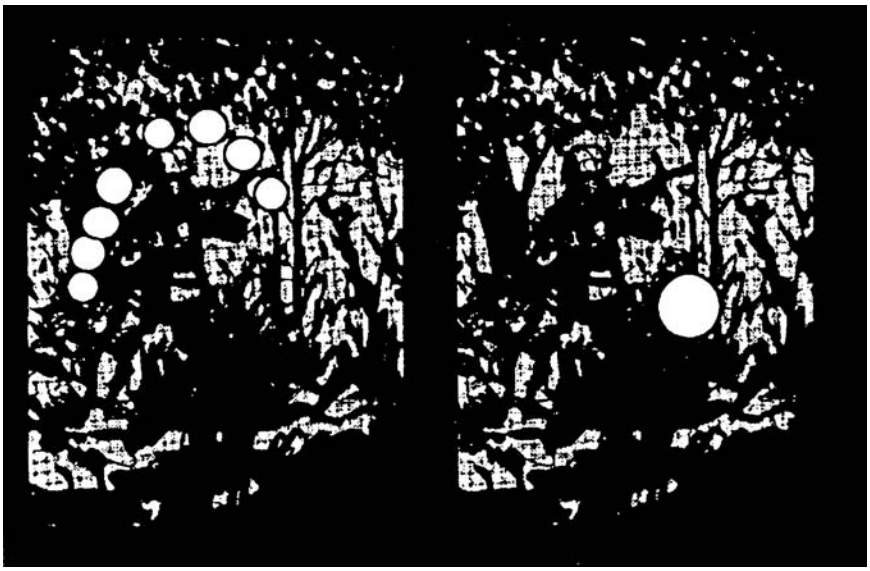

**Figure B-3. Off-center viewing technique.**

c. **Bleach-Out Effect**. Even when soldiers practice off-center viewing, the image of an object bleaches out and becomes a solid tone when viewed longer than two to three seconds. By shifting the eyes from one off-center point to another, the soldier can continue to pick up the object in his peripheral field of vision.

d. **Shape of Silhouette**. Visual sharpness is reduced at night; therefore, soldiers must recognize objects by shape or outline. Knowing the design of structures that are common to the area of operations enhances the success of the operation.